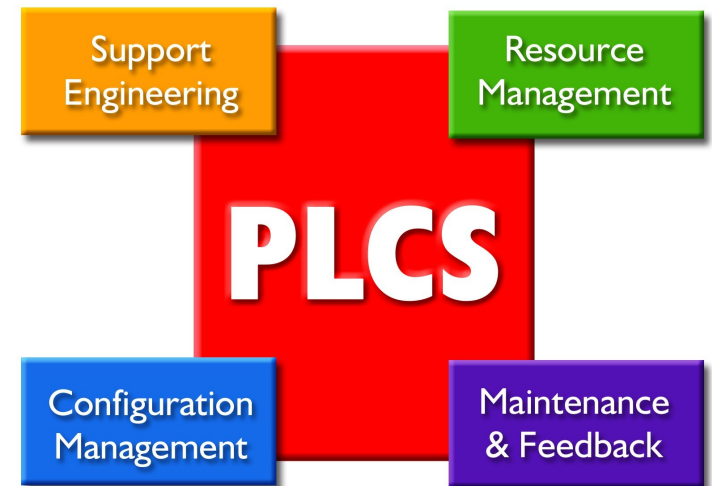


Product Life Cycle Support (PLCS)

The Information Backbone to transform the Logistics Enterprise

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BAE Systems

Chair, ISO TC184 SC4 Industrial Data
Co-chair, OASIS PLCS TC
Chair, eBusiness MoU Management Group



The PLCS Initiative



- ***The Business Context***
 - ❖ ***The key problem***
- ***Overview of PLCS***
 - ❖ ***Vision***
 - ❖ ***Approach***
 - ❖ ***Capabilities***
 - ❖ ***Status***
- ***Exploiting the benefits***
- ***Future plans***

Setting the Business Context

Business Drivers



- **Reduced Cost of Ownership**
 - ❖ *Users of products are seeking improved availability, reliability, maintainability and lower cost of ownership*
- **Sustainable Business Growth**
 - ❖ *Companies are seeking to make money through the life cycle support of their products to improve profits, improve quality and be more competitive*
- **Protect investment in product data**
 - ❖ *Users of information systems want to ensure long term usability for product information as IT and processes change*

Setting the Business Context

Digital Product Data has become a valuable business asset



- ***New Business Opportunities***

- ❖ *Leading manufacturers are 'going downstream' to generate additional revenue from supply of lifecycle support services*
- ❖ *Major users are seeking to outsource their support and information services*

- ***Product Lifecycle Management***

- ❖ *Businesses are focusing on total cost of ownership, as product life cycles increase and products become more expensive to maintain*
- ❖ *Increased focus on managing information throughout the product lifecycle - Concept to Disposal*

- ***Extended Enterprise***

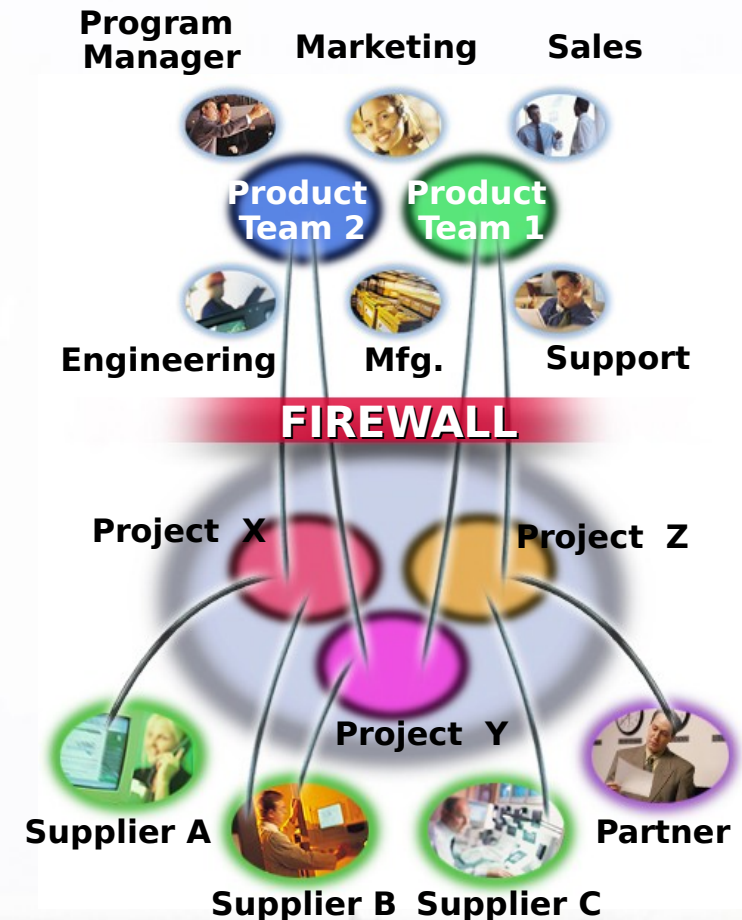
- ❖ *Increasingly complex business networks*
- ❖ *Not practical to adopt common system mandate*
- ❖ *Knowledge workers need to share information in real time*

Setting the Business Context

Requirements of the Extended Enterprise



- **Extended enterprises are formed to meet project specific requirements**
 - ❖ Partners may differ from project to project
 - ❖ Different partners are likely use different systems
 - ❖ Companies want a common way to exchange digital product data
 - ❖ Configuration Management becomes a key enabler for information exchange
 - ❖ Suppliers want a unified approach from Prime Contractors and OEMs
 - ❖ International collaboration demands product data exchange and sharing across many organizations
 - ❖ Worldwide operation demands a worldwide standard

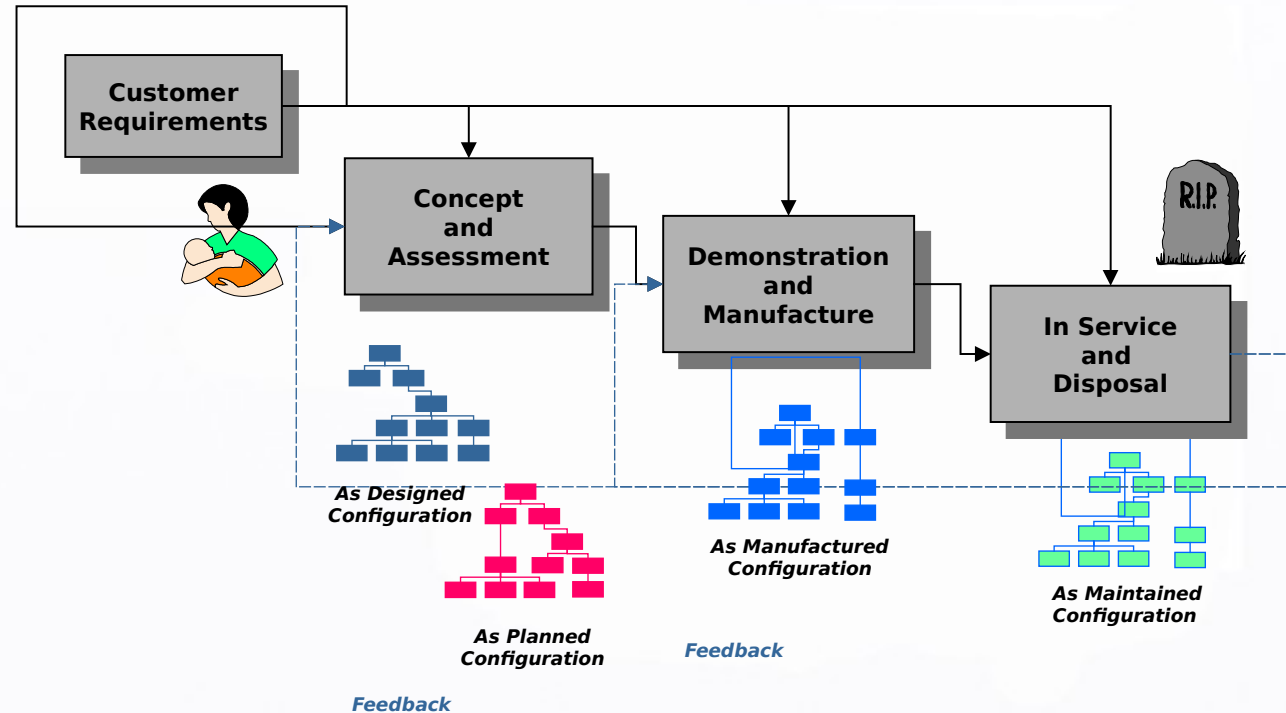


Setting the Business Context

Configuration Management is a major challenge



- ❖ *Multiple product views*
- ❖ *Major problems keeping information to operate and maintain a product aligned to actual product configuration through life*
- ❖ *Major problems linking support information to product information*
- ❖ *Inconsistent data definitions*
- ❖ *Software applications use proprietary data standards and are often difficult to integrate*



Setting the Business Context

Limitations with current standards



Current standards are specialized and focus on either:

- ❖ *a piece of a business transaction or process, e.g. Order Part; or*
- ❖ *presentation of specific content, I.e. Aircraft maintenance manual*

Example: Transaction oriented

- ❖ *Defence: ASD 2000M (ex-AECMA)*
- ❖ *Commercial: ATA Spec 2000, EDIFACT, ANSI X.12, ebXML*

Example: Content oriented

- ❖ *Manufacturing and process centric:*
 - *ISO 9000, STEP*
- ❖ *Operations and maintenance centric:*
 - *Defence: MIL-STD-1388, Def-Stan-00-60, ASD S1000D*
 - *Commercial: ATA Spec 2000, 2100*

Setting the Business Context

Imagine the opportunities if ...



- ❖ *Configuration management information was always accurate, up to date and immediately accessible*
- ❖ *Maintenance information was precisely tailored to the work to be done*
- ❖ *Spares and inventory costs were minimized through vendor involvement in an integrated supply chain*
- ❖ *In-service feedback was accurate, meaningful and readily available to product designers and support managers*
- ❖ *Change was easy to manage*

Setting the Business Context

The Key Business Problem



How to keep the information needed to operate and maintain a product aligned with the changing product over its life cycle?

***Product Definition
Information***

***Maintenance
Schedules***

Tools

***Test
Equipment***

***Support
Facilities***



Transportation

Consumables

Software

Spares

Training

***Storage
Requirements***

Product Life Cycle Support (PLCS)

The stakeholders



Finnish
Defence
Forces



BAE SYSTEMS



LSC GROUP

Pennant

INDUSTRIAL & FINANCIAL SYSTEMS



Product Life Cycle Support (PLCS)

The Initiative

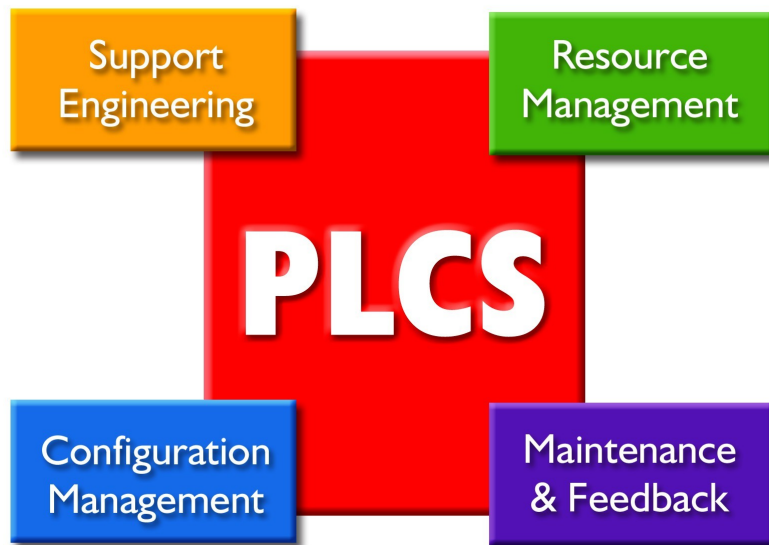


A joint industry and government initiative to accelerate development of new standards for product support information

An international project to produce an approved ISO standard within 4 years; ran from November 1999 - September 2003

PLCS is designed to ensure support information is aligned to the evolving product definition over the entire life cycle

PLCS extends ISO 10303 STEP - the Standard for Exchange of Product model data



Product Life Cycle Support (PLCS)

Available capabilities - ISO STEP



- ***STEP is an established international standard for the exchange, integration and sharing of product data***
 - ❖ ***Geometry***
 - ❖ ***Product structure***
 - ❖ ***Manufacturing interfaces***
 - ❖ ***Drawings***
 - ❖ ***Finite Element Analysis***
 - ❖ ***Printed Circuit Assemblies***
 - ❖ ***Wiring looms***
 - ❖ ***Mechanical Design***
 - ❖ ***Construction industry***
- ***Supports wide range of IT - ASCII, databases, XML, XMI,.....***
- ***Process modelling independent of data content***

Product Life Cycle Support (PLCS)

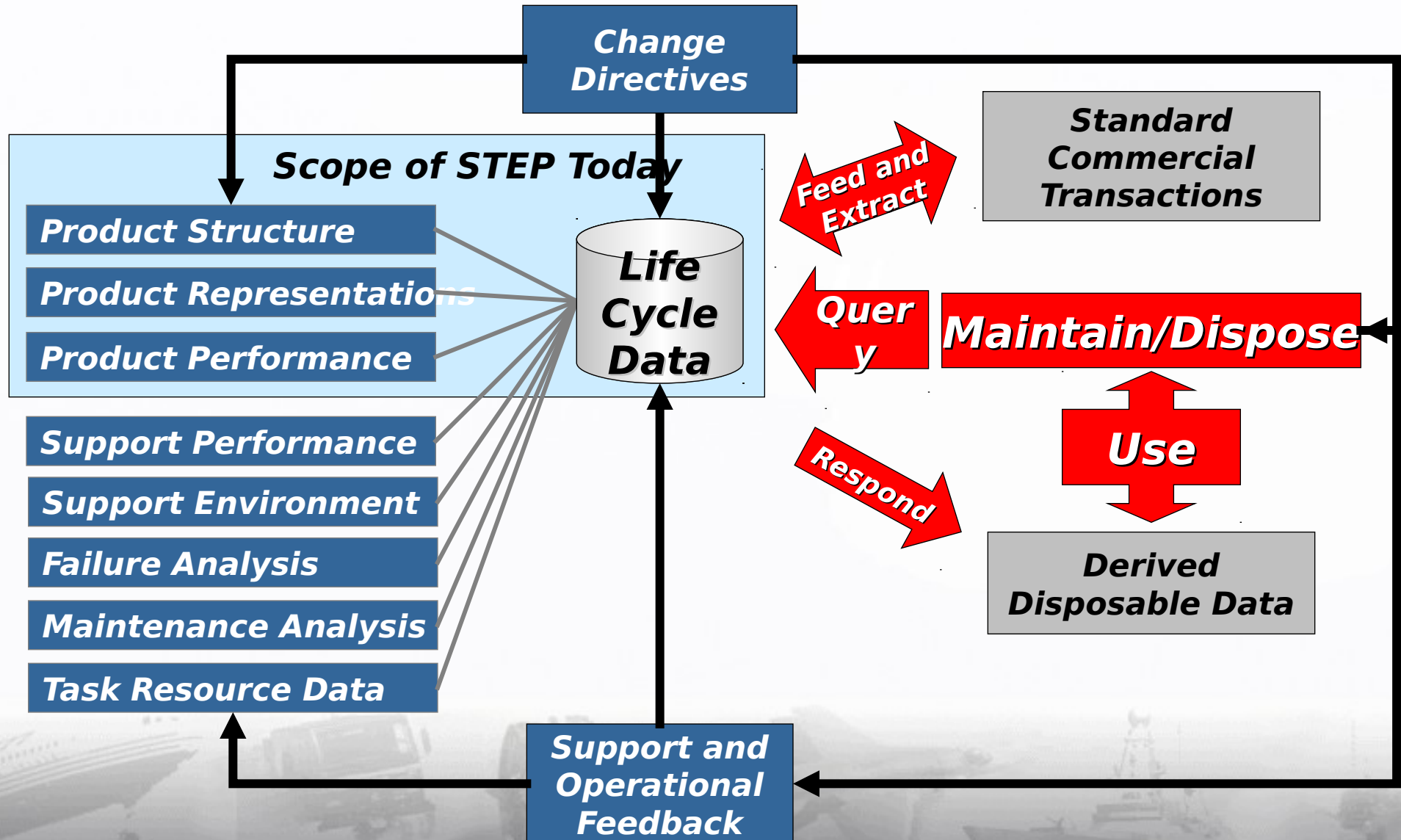
STEP in service



Product Data Management exchange for Eurofighter
Supplier interface for Lockheed Martin
Configuration Management and Digital Pre-Assembly
exchange at Boeing - RR, GE and P&W
Interface between A380 and its engines
IBM's global e-procurement design data exchange
Solid model exchange for Electric Boat
US and UK Navy RAMP programmes
Japanese SCADEC programme for the construction
industry
Ford CAD/PDM data integration
NASA Engineering information

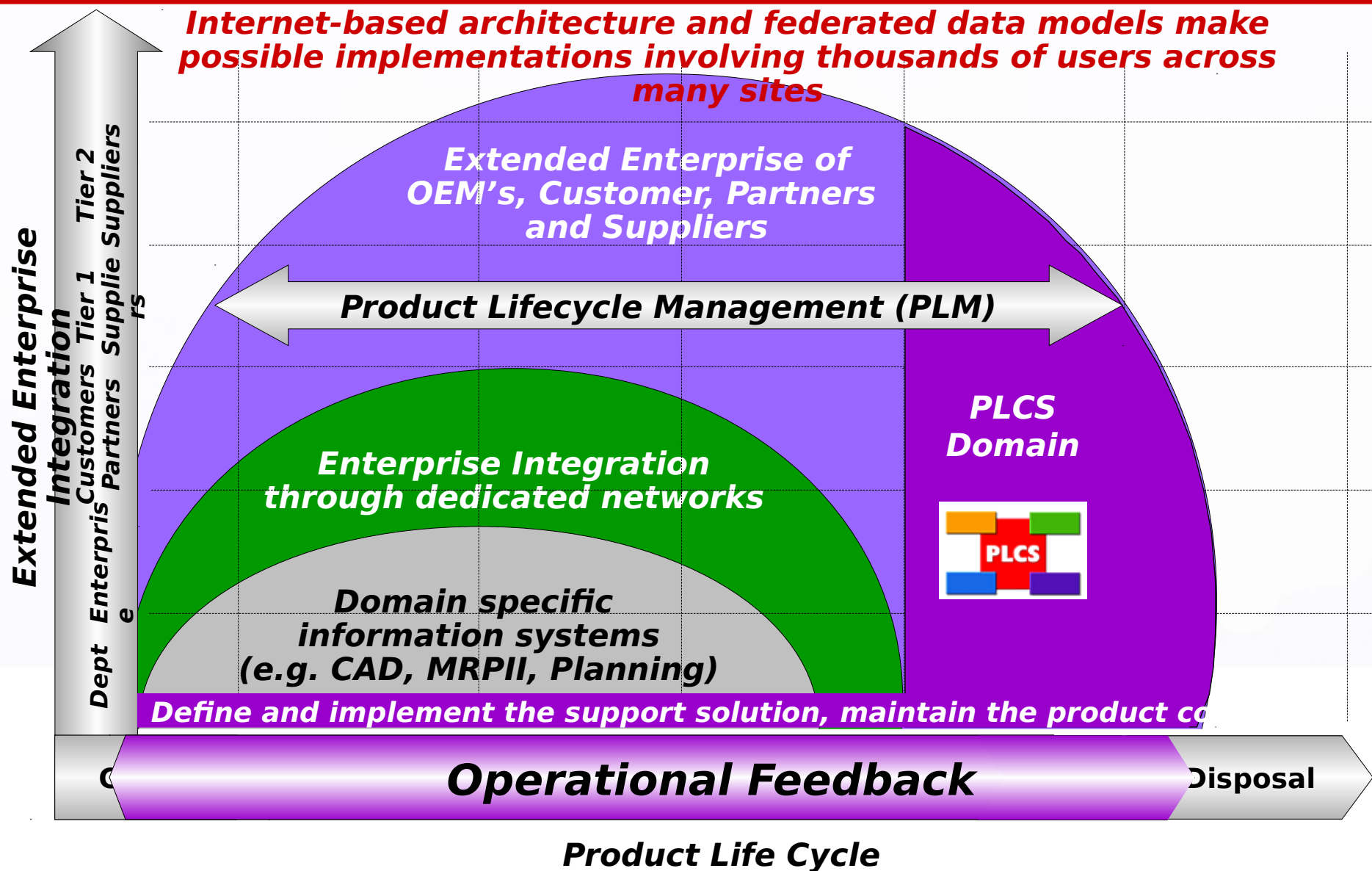
Product Life Cycle Support (PLCS)

The Vision



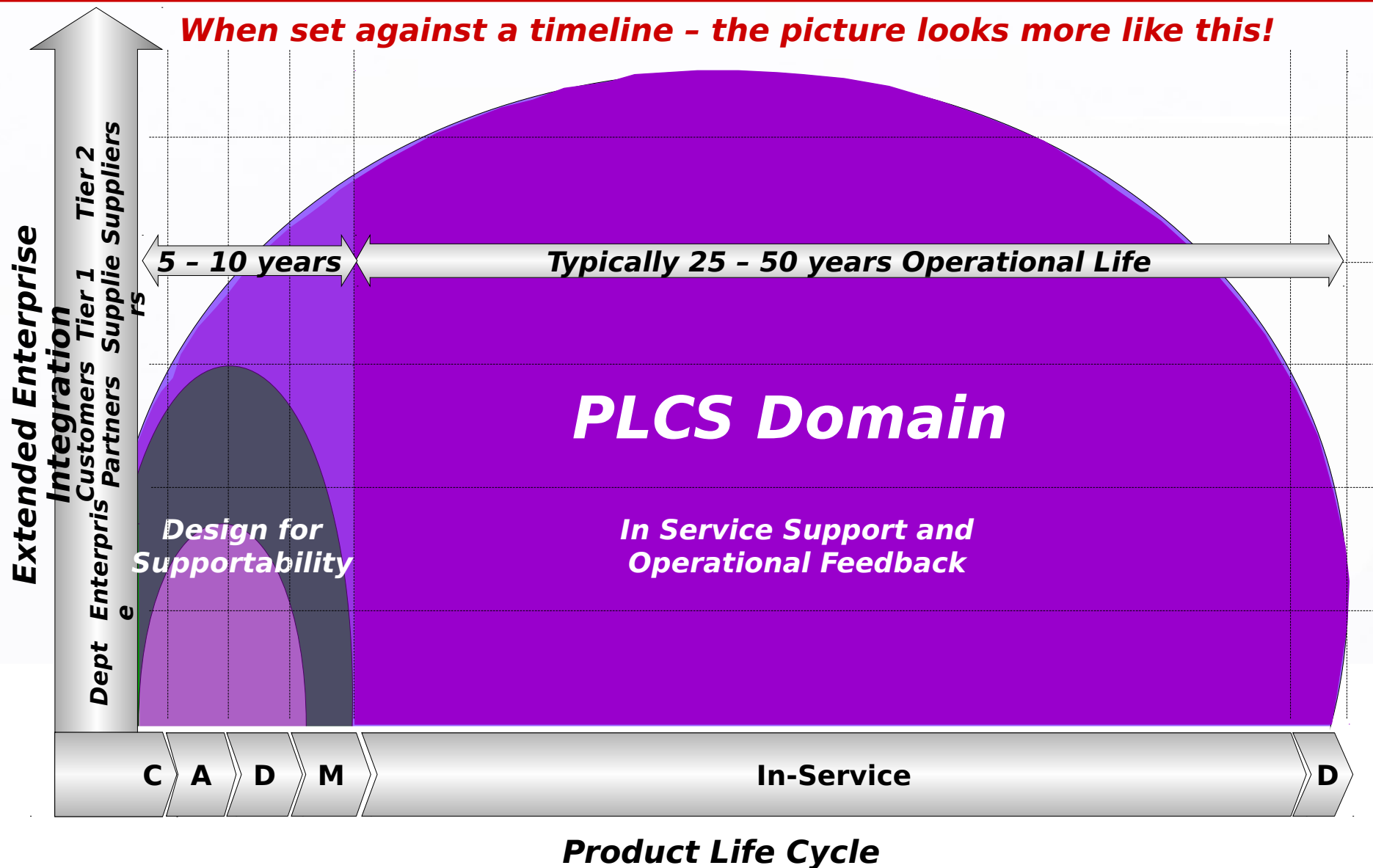
Product Life Cycle Support (PLCS)

Extended Enterprise enabled by Internet technology



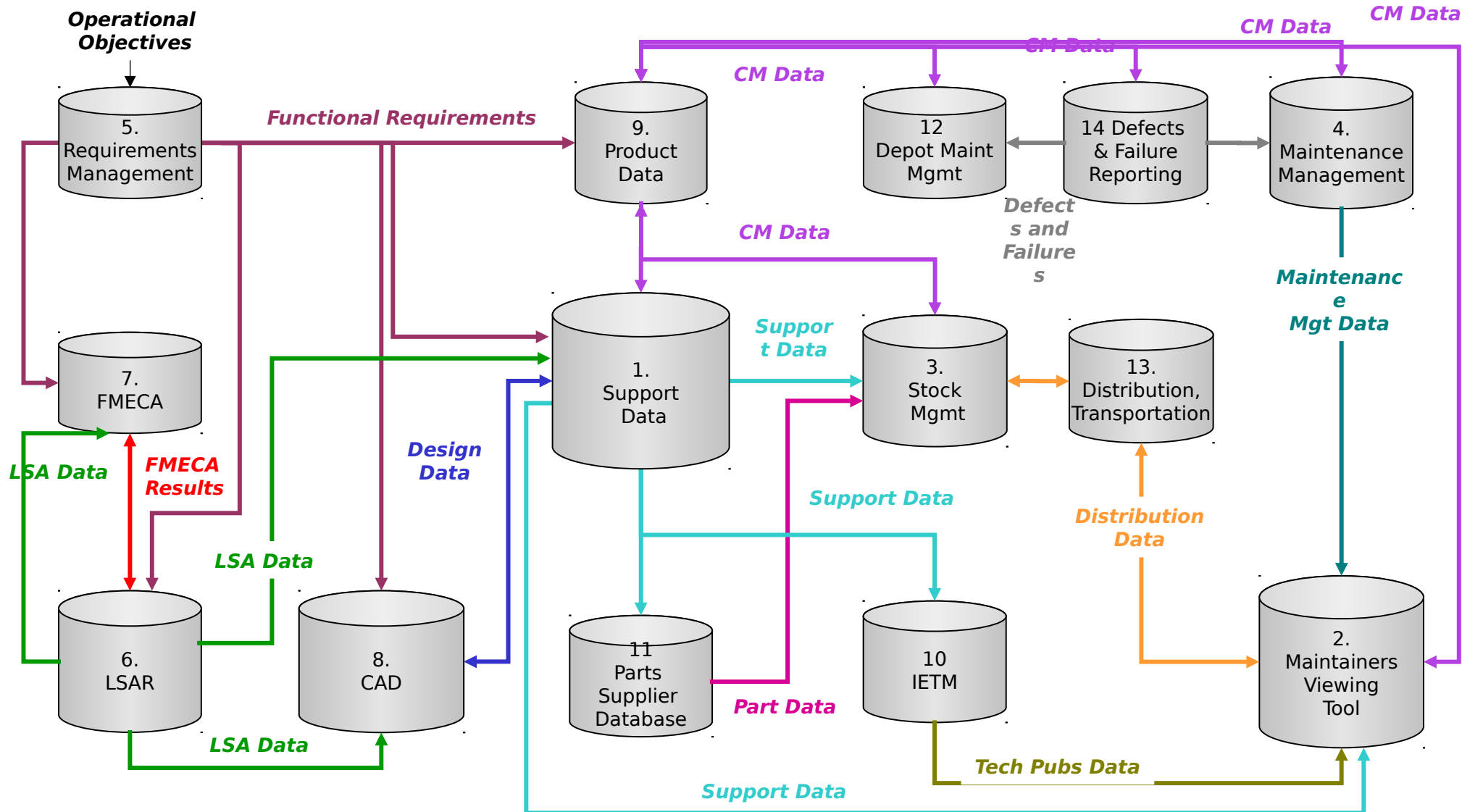
Product Life Cycle Support (PLCS)

Extended Enterprise - Importance of PLCS



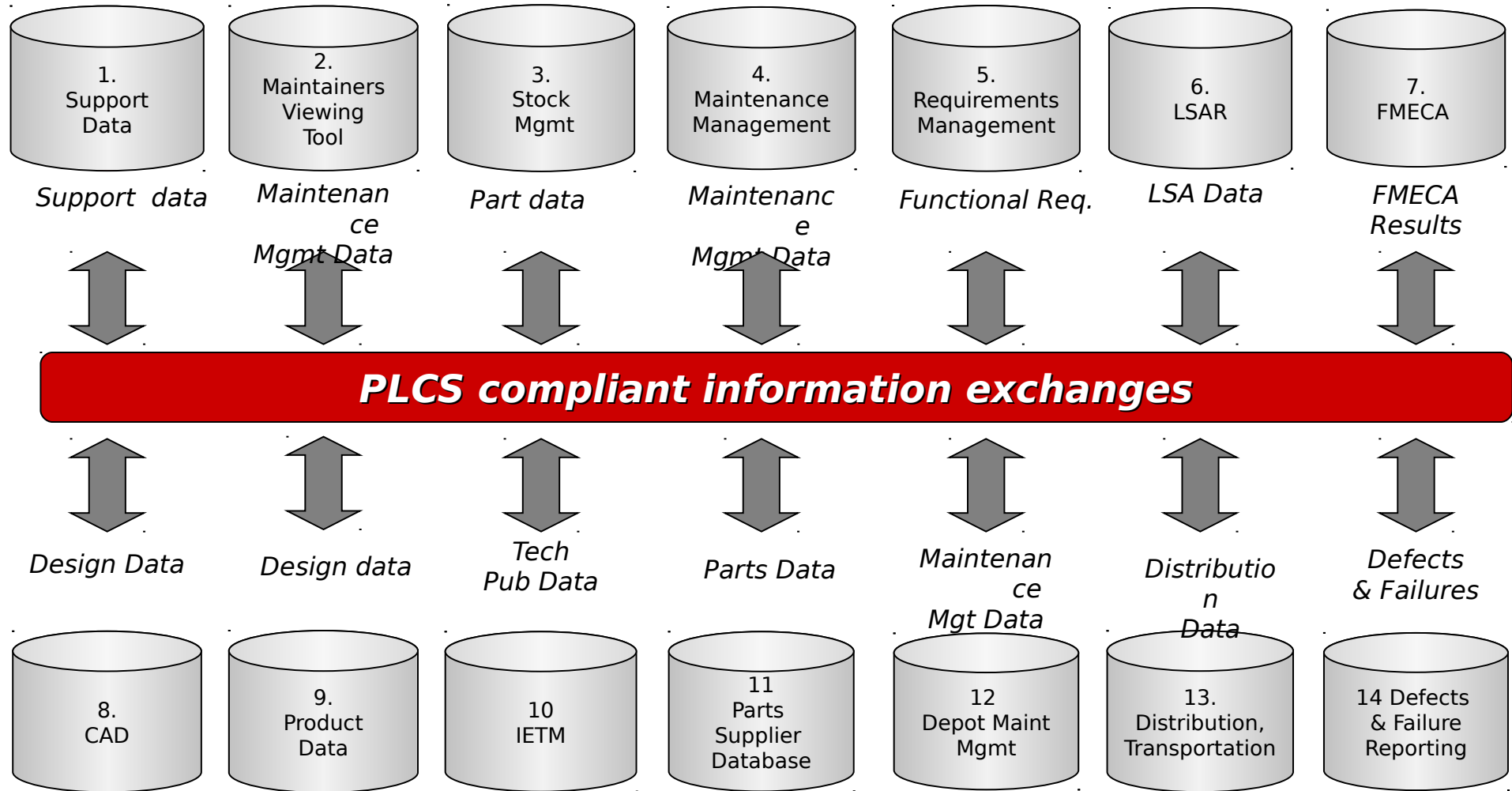
Product Life Cycle Support (PLCS)

Typically complex systems environment - point to point integration



Product Life Cycle Support (PLCS)

PLCS will enable cost effective information exchanges



In future, support system integration will be easier to implement

Product Life Cycle Support (PLCS)

Capabilities enabled by PLCS



Product Description

Capability to define product requirements and configuration, including relationships between parts and assemblies in multiple product structures (as-designed, as-built, as-maintained)

Work Management

Capability to request, define, justify, approve, schedule and capture feedback on work (activities) and related resources.

Property, State and Behaviour

Capability that describes and captures feedback on product properties, operating states, behaviour and usage

Support Solution and Environment

Capability to define the necessary support for a given set of products in a specified environment and to define support opportunity, facilities, personnel and organizations



- *A new vision for life cycle support*
- *A terminology dictionary*
- *An illustrative process model (AAM)*
- *A large data model, standardised through ISO 10303-239 (STEP AP239)*
- *Capability to define a set of data exchange sets (constrained subsets of AP239)*
- *Improved capability to tailor or extend the data model or exchange sets using external reference data (e.g. existing standards)*
- *A standardised interface to transaction standards/systems .. ebXML, Exostar, Covisint, S2000M - not achieved*

PLCS - Activity Model



- ***An IDEF0 model with 157 activities (boxes) and 220 information exchanges (arrows)***
- ***Purpose:***
 - ❖ ***1999/00: to define the scope of PLCS activity***
 - ❖ ***2001/2: to expose data requirements***
 - ❖ ***2003: to represent the activities and information flows supported by Application Protocol 239***
- ***Future use***
 - ❖ ***Communication the PLCS Vision***
 - ❖ ***Charting information exchange boundaries between organizations***
 - ❖ ***Identifying and illustrating DEXs***
- ***Available as .bp1, .idl, html, xml or pdf.***

PLCS - Activity Model Concepts



- **The PIF - Product in focus:** “what products do you want me to support?”
- **A PIF will be supported by one or more support solution definitions:** how to support these products
- **Each support solution definition is based on**
 - ❖ **A deployment environment**
 - ❖ **A support solution requirement**
- **The deployment environment defines:**
 - ❖ **A product group - a sub-set of the PIF needing tailored support**
 - ❖ **A usage pattern**
 - ❖ **A definition of the expected support organizations, locations, facilities and resources**
- **A support requirement is a structured requirement statement including performance metrics and targets for support performance**
- **Support metrics are required to enable:**
 - ❖ **Continuous optimization of support solution definition through life, based on feedback from use**
 - ❖ **Specification of an assessment strategy (what data to collect and how)**
- **A PIF scope may include many deployment environments and hence many support solution definitions**
- **These will be derived from a common set of task and resource descriptions**



- ***(Each) Support solution definition includes:***
 - ❖ ***Task specifications and task logic (e.g. diagnostic procedures)***
 - ❖ ***Relationship of tasks to the product configuration (including “effectivity” / “applicability” to all product versions)***
 - ❖ ***Specification of task trigger conditions based on:***
 - *State of individual product (as identified by UID)*
 - *Usage of individual product*
 - *Prior task or other events*
 - ❖ ***Identification and quantification of resources needed for each task, including a resource consumption model***
- ***Task specifications may:***
 - ❖ *point to an existing document*
 - ❖ *point to an SGML document (e.g. an ASD S1000D Module)*
 - ❖ *be fully “machine readable”*
- ***Task specifications may be linked to resources***
 - ❖ *Required resources*
 - ❖ *Resource items (products, people, facilities etc)*



- ***Assured Product Support Information comprises***
 - ❖ ***PIF scope***
 - ❖ ***Description of relevant deployment environments***
 - ❖ ***Support Solution requirements***
 - ❖ ***Product Definition Information (at least that needed for support)***
 - ❖ ***Support Solution Definitions***
- ***This full data set is subject to configuration change management***
- ***Related Information may comprise***
 - ❖ ***Test results***
 - ❖ ***Manufacturing records***
 - ❖ ***History of collected feedback on:***
 - *Individual product configuration over time*
 - *Product state and properties over time*
 - *Activities, including:*
 - ◆ *Product use*
 - ◆ *Work done*
 - ◆ *Resource use*



- **Create a durable data model standard that can be extended/adapted over time without re-modelling or re-ballot**
 - ❖ *Identify key generic concepts and relationships*
 - ❖ *Extend/adapt by classification and reference data libraries*
 - **Build on existing standards:**
 - ❖ *PDM Schema and the STEP Modular Architecture*
 - **Accommodate values that change over time**
 - ❖ *Support multiple values for the same property*
 - ❖ *Support back-tracking & audit*
 - **Maintain unambiguous histories**
 - ❖ *Product Structure, State, Activity*
- Aim: to enable optimisation of support through life**



- ***Main concepts***

- ❖ ***A large, comprehensive data model***
- ❖ ***Defined in EXPRESS to facilitate integration with other product data***
 - *Maps to multiple representation formats*
 - *EXPRESS-G graphical representation*
- ❖ ***153 Modules, ~500 Entities, ~1200 attributes***
- ❖ ***Can be extended using classification based on reference data, stored in external libraries (RDL)***
 - *Built around OWL*

PLCS is a Modular STEP AP



- **Modules allow common definitions of product data to be reused**
- **Extensive re-use of PDM modules**
 - ❖ **To bring compatibility with design/PDM tools**
 - ❖ **Basic work order/work request process common to change in design**
- **Extended to provide**
 - ❖ **Life cycle CM**
 - ❖ **Full work management capability**
 - ❖ **Condition based task triggers**
- **All modules feature two levels of model, with mapping**
 - ❖ **User view of information**
 - ❖ **Link to common concepts across all of STEP**
 - ❖ **Full harmonization achieved where needed by common modules**
 - **With CAD/PDM via PDM Modules**
 - **With Requirement Tools via Systems Engineering modules**

PLCS enables requirement management through life



- ***AP239 will share common modules with AP233 - Systems Engineering (currently in draft):***
 - ❖ ***Text-based Requirements***
 - ❖ ***Multiple, related breakdowns, including “System” concept***
 - ❖ ***Interfaces***
- ***Aim is to support requirements trace from pre-design through to maintenance and disposal***
- ***UK MOD has funded demonstration project for this capability with BAE Systems***

PLCS provides full history to support optimization and change over time



- ***In the PLCS models it is assumed that any value supplied***
 - ❖ *E.g. a property such as mean time to perform a task****may have multiple values over time***
where each value could have been:
 - ❖ *supplied at different times*
 - ❖ *by different people*
 - ❖ *subject to approval*
 - ❖ *subject to security classification*
 - ❖ *Have an associated justification/probability/risk*
- ***This requirement has been recognised from the start of modelling***
- ***Improve CM of support information by use of “single source” Assured Product and Support Information (APSI)***

PLCS - Life Cycle PDM Capability (1)



- ***PDM Schema already supports automated exchange of***
 - ❖ *Part id and properties*
 - ❖ *Associated documents and files (incl. CAx)*
 - ❖ *Product structure*
 - ❖ *Product (and document) approval status*
 - ***This is already in production use by***
 - ❖ *US Aerospace and Defence prime contractors (via AP203)*
 - ❖ *German/Swedish/French Automotive sector (via AP214 cc6)*
 - ❖ *Eurofighter Typhoon PDM partners*
- .. A powerful and proven capability for Configuration Management of a complex product design***

PLCS - Life Cycle PDM Capability (2)

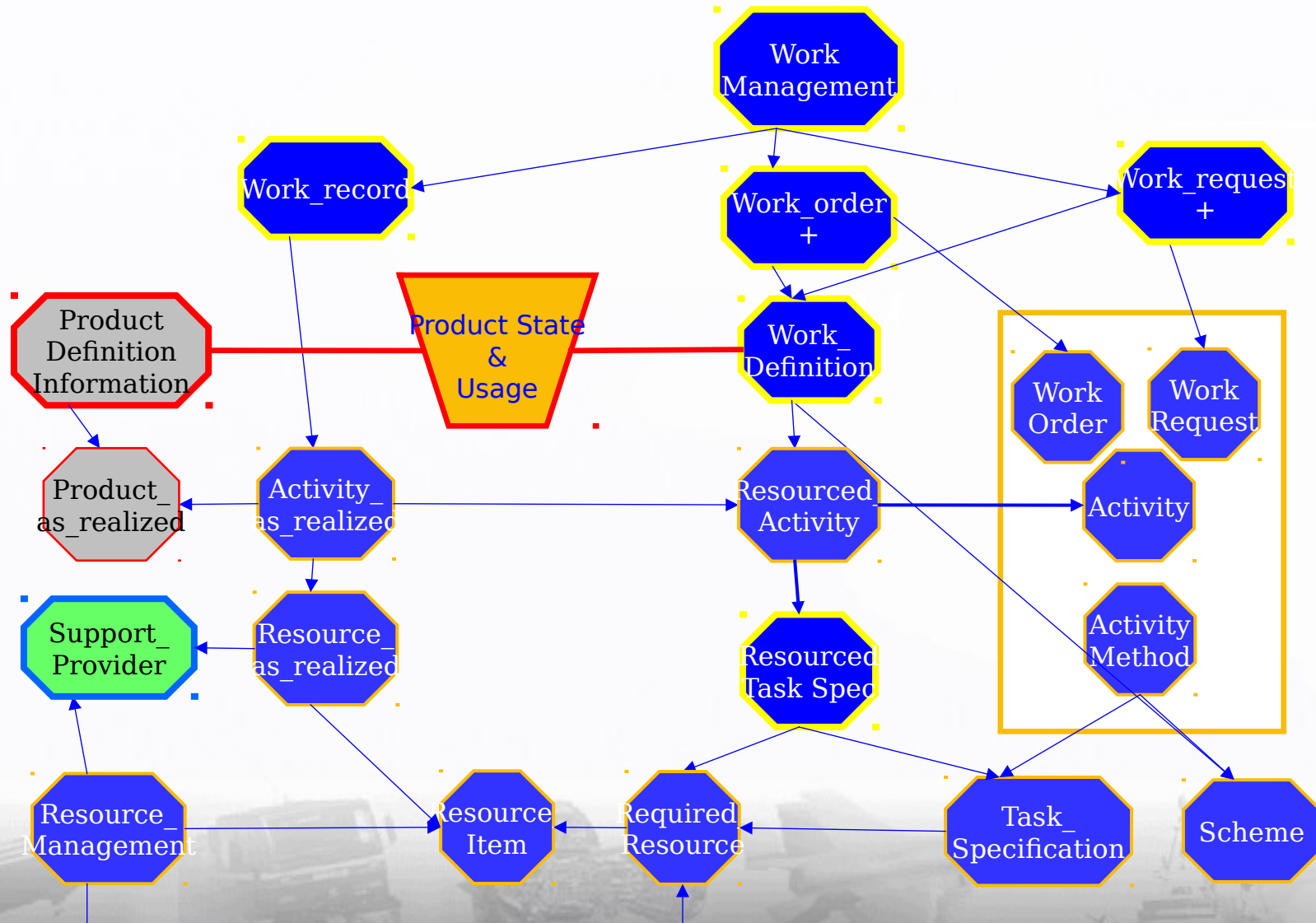


- ***AP239 has added:***

- ❖ *Classification, supported by reference data libraries*
- ❖ *Product_as_individual (planned and realized) - UID*
- ❖ *Product breakdowns (system, physical, functional, zonal and hybrid)*
- ❖ *Text based requirements (from AP233)*
- ❖ *Extended property capability*
- ❖ *Interfaces*
- ❖ *Attachment_slot*
- ❖ *Message, Envelope (similar to ENGDAT)*
- ❖ *Information Rights*

... A powerful capability for Life Cycle Configuration Management of Assured Product and Support Information

PLCS - Work Management modules





- ***What is it?***

- ❖ *Values for attributes that are agreed and defined in advance of use*
- ❖ *E.g types of task, grades of people, types of products, types of document*
- ❖ *E.g. Nato Stock Number - classifications*

- ***Why use it?***

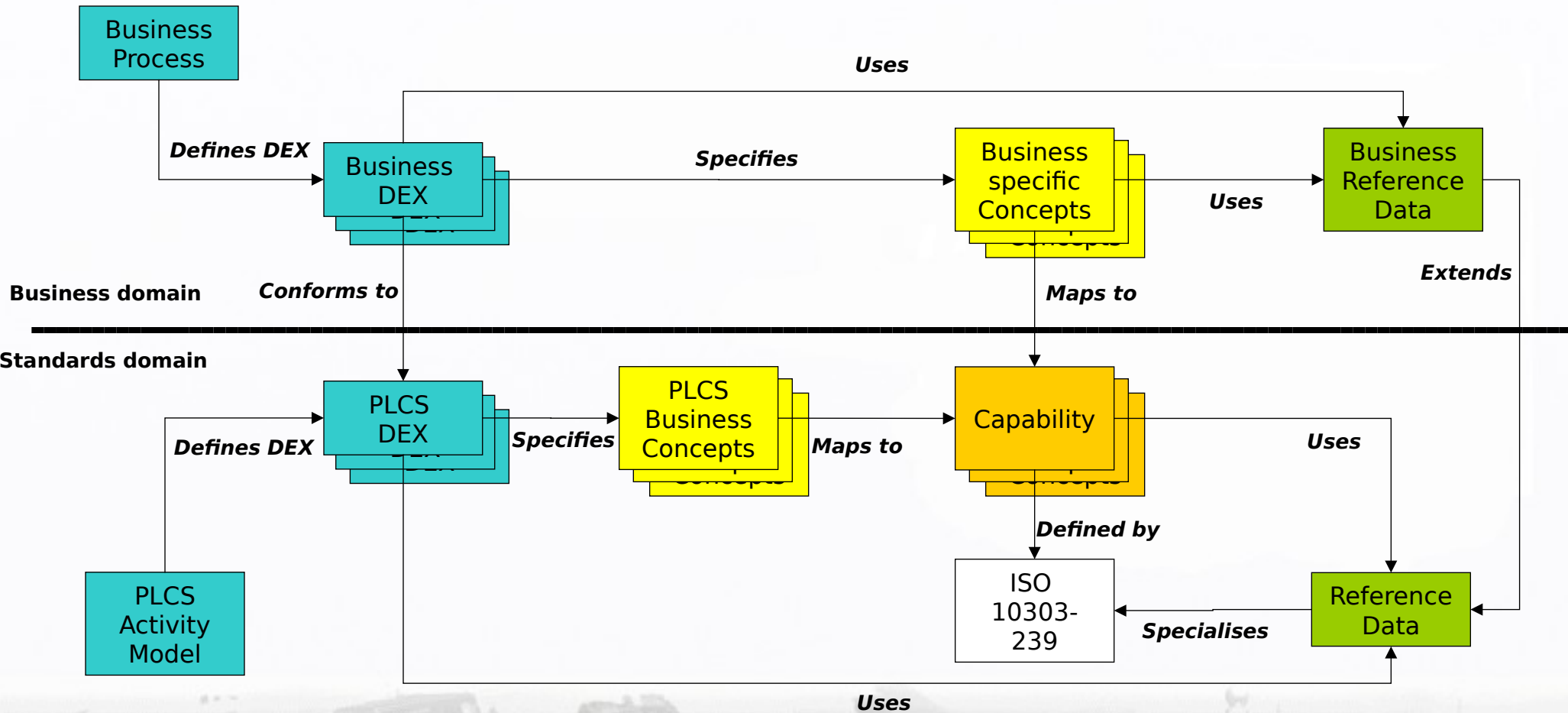
- ❖ *Because it improves reliability and effectiveness of exchange*
- ❖ *Because it can be extended:*
 - *To add to the scope of the standard*
 - *To provide project specific capabilities*
- ❖ *Because it supports re-use of values from existing standards*

- ***Idea proven in Oil and Gas industry***



- ***DEXs are:***
 - ❖ *Subsets of the AP239 Information model*
 - ❖ *Selected to meet a specific data exchange need*
 - ❖ *Built from relevant modules*
 - ❖ *Supported by Usage Guidance, population rules and Reference data*
 - ❖ *Can be refined from other DEXs*
- ***DEXs may be standardized at any level (work group, company, project, organization, national, international)***
- ***DEXs enable***
 - ❖ *Consistent implementation of AP239*
 - ❖ *Data consolidation through time*

DEX Architecture



Current PLCS DEX developments



- *Product as individual*
- *Product breakdown for support*
- *Maintenance plan*
- *Task set*
- *Operational feedback*
- *Fault states*
- *Work Package Definition*
- *Work Package Reporting*
- *Plus a range of developments which apply additional constraints and reference data based on generic DEX*

Current situation (February 2006)



- ***Activity Model published (available to all)***
- ***1750 requirements allocated to 153 modules***
- ***Modules published by ISO as Technical Specifications:***
 - ❖ ***PDM modules***
 - ❖ ***PLCS modules***
 - ❖ ***AP239 information model***
- ***Draft International Standard ballot for Application Protocol 239 successfully completed 13 September 2004, with unanimous acceptance***
- ***Publication by ISO dated 1 September 2005, available as hyperlinked CD-ROM product***
- ***Development of first eight Data Exchange Sets under way***
- ***Implementation activities are gaining momentum in Norway, Sweden, Finland, UK and US***

Product Life Cycle Support (PLCS)

Unique Value Proposition



- ***International Standard for product support information - based on the ISO 10303 standard for product data (STEP)***
- ***Complete product lifecycle - from concept to disposal***
- ***Single source of assured product and support information***
- ***Data independence from Processes and Systems***
- ***Interoperability across enterprises and systems through:***
 - ❖ ***Standardization of semantics for product support***
 - ❖ ***Integrated suite of data models for data exchange and information sharing***
 - ❖ ***Utilization of ISO STEP standards, methods and tools***
- ***Extensibility and tailoring through the use of Reference data libraries***

***Customers, Contractors and Software Vendors
working together to develop and implement
a neutral data exchange standard for product support***

Exploiting the benefits





- ***The standardized PLCS information model can be implemented in 3 ways:***
 - ❖ ***As an **integration architecture** for product life cycle support management systems and information***
 - ❖ ***As a **mapping** between systems (APIs)***
 - ❖ ***As a standardized **data exchange** capability (plus compliant software)***
- ***STEP technology supports all three and is language independent (Cobol, Java, C++, XML)***
- ***STEP is in production use, with proven benefits, for CAD, CAM and PDM systems***
- ***PLCS can also be used to promote further standardization via Reference Data (e.g. fault codes, skill grades)***

Implementing PLCS for a new program



- ***Use PLCS/STEP formats to capture design information as it is generated in a way that support engineers can re-use***
- ***Develop Support Information in PLCS format***
 - ❖ Less duplication - single assured source
 - ❖ Easy to present/deliver in any required form (e.g. S1000D, XML, PDF)
 - ❖ Improved management of effectivity/applicability
- ***Deliver a PLCS enabled maintenance management capability***
 - ❖ Automatic upload from single assured source
 - ❖ The right data is available for maintainers (can be tailored to serialized item)
 - ❖ Improved feedback collection
 - ❖ Better in-service metrics
 - ❖ Faster learning
- ***Identify DEXs for specific exchange requirements***

Implementing PLCS for an existing program



- ***Identify current information shortfalls or problems***
- ***Use the PLCS Activity Model to identify relevant data exchanges that cross IT system boundaries, within and beyond your company***
- ***Implement appropriate DEXs, where there is a valid business case***
- ***Identify new DEXs if required (business, company, national or sector level)***
- ***Consider adopting PLCS for new data generated (changes, modifications, upgrades etc.)***
 - ❖ **Most current formats can readily be delivered from a PLCS integrated source. The latter is cheaper to build and easier to maintain.**
- ***What NOT to do - immediately abandon current systems (and standards) that meet business needs***

Benefits from data quality



- ***PLCS provides standardised rules and relationships for information***
- ***Converting to standard form will reveal many of the inconsistencies in existing information sets***
- ***Need to apply resources to cleanse existing data***
- ***MUCH cheaper than discovering errors later!***

Future Plans





- ***ISO TC184/SC4 is responsible for “Industrial data”***
- ***Working Group 3 is responsible for “Product modelling”***
- ***Team 8 is responsible for “Product life cycle”***
- ***Team 8 will retain responsibility for AP239***
- ***Resources committed through national standards bodies***
- ***Also provides active liaison to Systems Engineering development***

DEX Development and publication



- ***Open-source infrastructure developed***
- ***Seeking more open participation***
 - ❖ ***lower cost entry***
- ***Need enhanced links with other information standards development***
- ***Selected OASIS consortium as parent***
- ***Formed OASIS Technical Committee for “Product Life Cycle Support”***
- ***Open to all OASIS members***
- ***Operating under OASIS rules***
- ***Depends on resources contributed by participants***

- ***The purpose of the OASIS Product Life Cycle Support TC is to:***
 - ❖ ***establish structured data exchange and sharing capabilities for use by industry to support complex engineered assets throughout their total life cycle***
 - ❖ ***define, develop, test and publish OASIS Product Life Cycle Support DEX's based upon ISO 10303 (STEP) Application Protocol 239 (Product Life Cycle Support).***
 - ❖ ***liaise with ISO TC 184/SC4***
 - ❖ ***coordinate with relevant OASIS Technical Committees***
 - ❖ ***promote the use of OASIS Product Life Cycle Support DEX's across industries and governments world-wide***

The way ahead



- ***The PLCS consortium has delivered the basic standard, and an infrastructure for exploiting it, and has closed down***
- ***Join in an early implementation***
- ***Join the OASIS Technical Committee to participate in DEX development***
 - ❖ ***See [WWW.oasis-open.org](http://www.oasis-open.org) and select PLCS***
- ***Contribute to further developments in ISO through your national standards body***

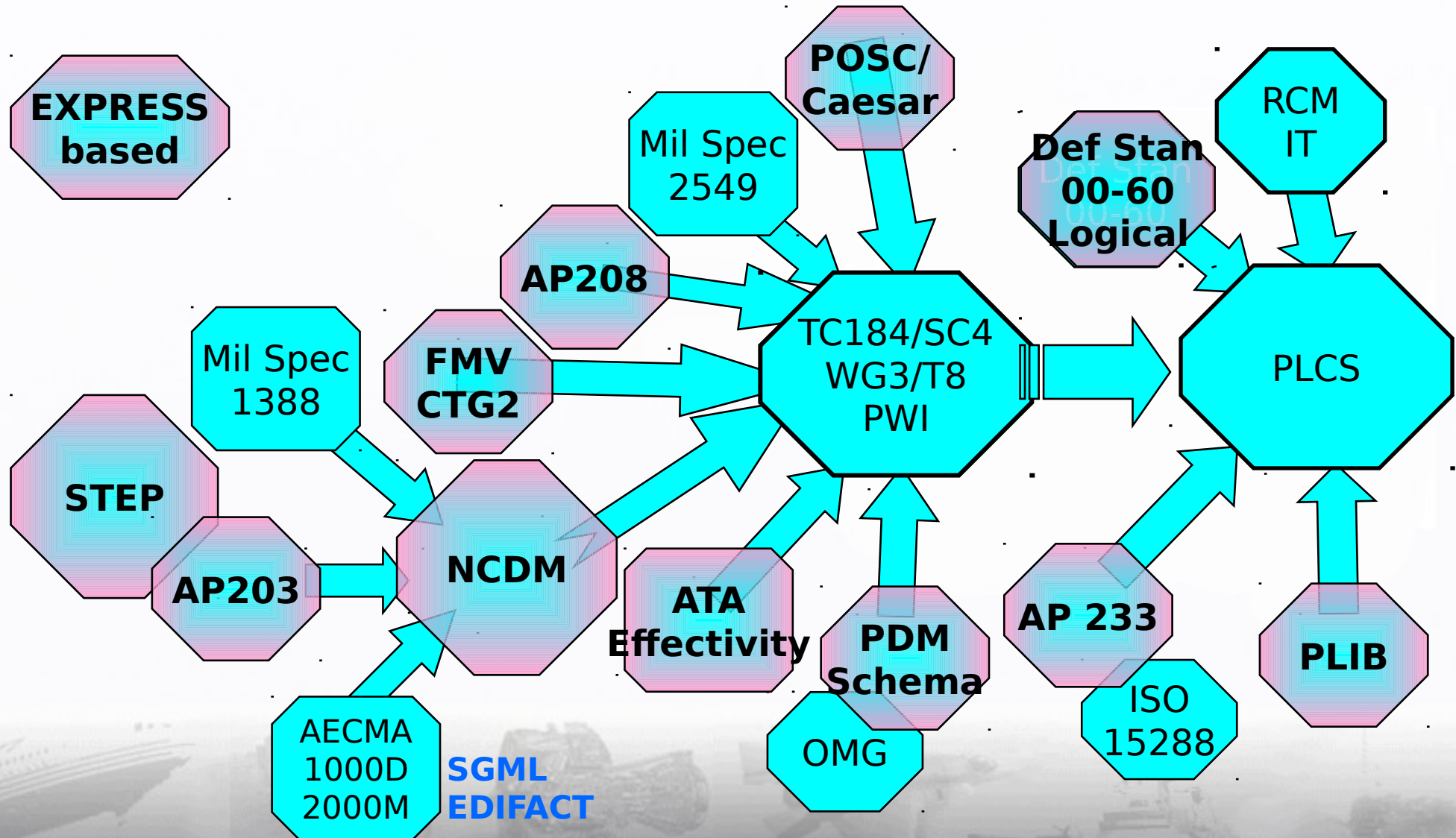


***“If we reach high,
we do so only because
we stand on the shoulders
of those who went before”***

(Albert Einstein)



PLCS: Relationship to other standards



PLCS: Relationship to other standards



- ***Current position***

- ❖ *PLCS can use the data generated by current ILS standards*

- ***The opportunity***

- ❖ *PLCS can enable much higher levels of data integration*
- ❖ *PLCS, and other factors, will drive change in most current ILS standards*
- ❖ *The pace and direction of this change depends on market factors*

- ***The challenge***

- ❖ *To exploit the development of PLCS to deliver improved logistics services and capabilities*

Product Life Cycle Support (PLCS)

The Information Backbone for the Enterprise

Questions?
Answers!

